CAMPUS BICYCLE FOR IIT BOMBAY

MOBILITY AND VEHICLE DESIGN PROJECT II

ALVIN P GOPAL
126390009

GUIDE
PROF. K. RAMACHANDRAN

INDUSTRIAL DESIGN CENTRE
INDIAN INSTTITUTE OF TECHNOLOGY
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Declaration

I declare that this report represents only my idea in my own words, and where others Ideas or words have been included, I have cited and referenced the original source. I also declare that I have adhered to all principles of academic honesty and integrity and have not falsified, misinterpreted or fabricated any idea/data/facts/sources in my report. I understand that any violation of the above will be cause for disciplinary action by the institute and can also invoke penal action from the sources from which proper permission has not been taken, or improperly cited..

Sign : 

Name : ALVIN. P. GOMEZ

Roll No : 12639009

Date : 14/11/2013.

Approval sheet

This Mobility and Vehicle Design project report entitled "Campus bicycle for IIT Bombay", by Alvin P Gopal is approved in partial fulfilment of the requirements for Master of Design degree in Mobility and Vehicle Design.

Project guide :

Chairperson :

Internal examiner :

External examiner : Mark.

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Contents

1. Abstract

The aim of this project is to make a unisex bicycle for IIT Bombay students. This bicycle can be used by male as well as female students of the campus. Project deals with an attempt to understand the current commuting pattern of the students within the campus periphery and to identify problems.

The existing campus bus service is not enough to handle the increasing number students. As an institute of national importance, IIT Bombay has been encouraging more sustainable, healthy and eco-friendly mode of vehicles for campus commuting. Educational institutes abroad have bicycles being extensively used for campus commuting mostly through bicycle sharing system. Concept of campus bicycle is not very common in India, however, there is scope for such a product.

The project have started with market research to understand the current trend and existing products. Next step was the user study, including questionnaire survey and observation. The target user is the student community of IIT Bombay. The user study helped to understand the various user needs and their current problems. The climatic factors were also considered as a part of design process. A basic study of material was also done, which gave the directions to finalize the appropriate material for manufacturing. The insights from research part were considered to formulate the design brief. Based on design brief, various concepts have made and conducted and an evaluation by various users. Based on the concept evaluation, the one which got maximum preference was selected as the final concept and made a 1: 1 working prototype.

The designed cycle can be used as a part of campus bicycle sharing system as well. Project makes an attempt to understand the basic needs of the students including the functional and aesthetical aspects.

2. Introduction

Increasing pollution and rising fuel cost forced human, to go for non polluting and economical vehicles for their daily commuting. Whole world is trying to find out more cheaper and green vehicles. In India more people are opting motorized vehicles. The non polluting non motorized and cheapest vehicles like bicycles are getting least preference in our country .

It has been widely accepted fact that riding a bicycle is good for human health and the environment. Many cities in the world such as Amsterdam, Barcelona, Berlin, Copenhagen, Paris in Europe and Boulder, Chicago, Beijing in Asia, Perth in Australia have selected cycling as one of their prime mode of transport.

Changing our road condition to make it comfortable and safer for cycling is not a very easy task and is not in our hands. The best way is to create awareness and bring pressure on the policy makers to act. At present, apart from the perilous Indian roads and highways, the safer roads for cycling is only available in the campuses of Indian universities and higher educational institutes, where a large number students, staff and faculty live and travel on campus

2. A. Purpose of the project

Cycling is a relatively cheap form of transport. It helps to keep us fit and healthy and is emission free making it good for earth. The purpose of my project is to design a bicycle for IIT Bombay, which have to satisfy the basic commuting needs of the students. Thus try to improve the campus bicycling and convert IIT Bombay in to a bicycle friendly campus. In this project I mainly concentrated to study and analyse the current cycling, usage, needs and the transportation problems facing by IIT Bombay students.

2. B. Scope of the project

As an institute of national importance IIT Bombay have the responsibility to follow the environmental values for the betterment of our society. In future, I would like to extend my Campus bicycle in to a more bigger level like a Campus bicycle sharing system.

2. C. Process followed

My project has started with the data collection followed by the data analysis. The analysed data has been culminated and tried to identify the needs and problems of the users. From the culminated data, design directions and design brief have evolved. Technical layout has been made with reference to the relevant bicycle and detailed engineering drawing were prepared,.

With reference to the final design brief and technical layout initial ideations have started, and the concepts which were matching with the design brief have short listed. A basic technology study have done to get an idea about the various technical possibilities available. The shortlisted concepts were evaluated among the users with the various parameters taking in to consideration. Each parameters have given certain value of weightage ranging between 10-20 and rated them with points between 1-10.

The final point(product of weightage and points) of each parameters of various concepts were added separately and the cumulative points were compared and the one which got the maximum point has been selected as my final concept. The final concept is then taken for the last fine tuning and detailing. Various renderings of the same have been made and kept ready for model making.

3. Initial research

As mentioned earlier my project started off with data collection which helped me to under stand the various aspects related to this particular topic. The processes followed in data collection are as given below.

3. A. Domain study

Data collection began with a brief study about The Indian Institute of Technology Bombay (IIT Bombay) . Which is a public engineering institution located in Powai, Mumbai, India. It is the second-oldest institute of the Indian Institutes of Technology system and was founded in 1958. The Institute is having a 220 hectares of green campus in the north eastern suburbs of Mumbai.
IIT Bombay has a total of 14 academic departments, eight centres, three school, and four interdisciplinary programmes and having more than 8500 students[1].

The Indian Institute of Technology (IITB) offers residential facilities to all its staff, faculty members and students. The students are staying in hostels numbered from1 to15. Another hostel named Tansa is allotted for research scholars.

3. B. Commuting pattern inside the campus

As far the campus commuting is concerned students have no permission to use any motorized vehicles inside the campus, but others have. That make difficulties to the students for campus commuting. As a solution to this problem, the Student Welfare Society (SWS) is providing the Tum-Tum service, the campus bus service in the institute. This body is primarily responsible for the monitoring and operation of the Institute Transport System. At present time there are 19 buses, running in three consecutive shifts, Morning 7 am – 3 pm, Evening 3 pm – 11 pm and night 11 pm – 3 am. Tum-tums are covering almost all possible regions of our campus viz. Main gate, YP gate, lakeside, Hill side, SAC, Hostel 5, Hostel 14 from the starting point near to Shailesh J.Mehta School of Management (SOM). All these vehicles run on CNG, which is not available during the night and hence all vehicles have to be necessarily refuelled during the day. In order to avoid the interruption of services during the peak hours of morning, most of the vehicles are sent

out side for refuelling in the afternoon. The uncertain traffic condition of out side some times make these buses to come late, which will in turn alter the daily schedule.

After 7 pm some of the buses will stop their service and there will be only 3 buses in the night shift. Since many of the IIT students are staying late in their departments, they might need some travelling facility to go back to their hostels. Night tum-tums were started to help students who can't ever find a rickshaw at night, and operate at each half an hour drive through the entire institute to drop students off. So if the students are not coming in time they will miss the bus and they have to walk all the way to their hostels in the night.

Many days, due to the unexpected driver strike, mechanical complaints or other reasons few of the tum-tums will stop their service with out any prior information. That will create unwanted rush of the students. More over the students are not well informed about the tum-tum timing. So many times the effective transit of students by tum-tum is not happening.

According to, a supervisor of the tum-tum service, the peak time of students is from 11.30 am – 2.30 pm and 4.30 pm – 6.30 pm. The aim of SWS was to provide a cheap bus transport, reduce environmental damage and facilitate commuting within the campus. Most of the students are not happy with the current system, because of the lack of information about the tum-tum timetable and it's frequency. This will make the students to go for other solutions like auto rickshaws. This trend will invite more rickshaws, in to the campus, that will eventually increase the traffic volume with in the campus, which is not desirable.

There are some interesting talk among the students regarding the tum-tum.

1. (a) tum-tum is seen only when you are half way between 2 stops
(b) almost reaching your destination after walking around 1.2 km.

2. When waiting at a tum-tum stop, you always see one go in the direction you don't want to go in or you get one in your direction that's full already.

3. For every tum-tum that's going in one direction, there's one going in the other. However, it's unlikely you'll get into either since it's so badly full already. [2]

3. C. Scenario study

Pic-1, Students are coming out from their hostels, and walking towards the college. Time is about 9 am.

Pic-3, The tum-tum didn’t stop, again waiting for the next to come.

Pic-2, Few of them are waiting for tum-tum and few are still walking and cycling

Pic-4, Still waiting for the next bus

Pic-5. Another bus came, every one rushing in to the bus, but overcrowded.

Pic-7. Remaining people are again waiting for the next bus

Pic-6. The bus started moving but few of them are hanging and few could not board

Pic-8. After few minutes another location, more students are waiting for tum-tum

Pic-9. It is so boring to wait, and it is already late around 9.30 am

Pic-11. Next bus came and they are fighting each other to get in to the bus.

Pic-10. One tum-tum is going, but it is full

Pic-12. Dangerously hanging outside

Pic-13. One boy catches an auto

Pic-15. Still tum-tum and rickshaws are wandering…

Pic-14. Lot of them have to walk, they didn't get tum-tum or auto.

Pic-16. Finally if there are no students our tum-tum will come to help them.

Pic-17. Sometimes near to hostel 12 we can see another rickshaw stand !!!

Pic-19. During peak hours the road in front of SJSOM is more crowded

Pic-18. Improper scheduling causes, over crowding tum-tums at one location

Pic-20. Over the speed of vehicles, can invite accidents.

Considering all these factors dependence on the tum-tum service or rickshaws is risky tedious, time consuming and non economical. How ever the students who are walking or cycling are independent and more flexible to reach their destinations with in the time. Any change in the schedule of service will create unavailability of the buses that will in turn cause wastage of time.

On many occasion out side vehicles rules over the campus transport system. Why should our students encourage this kind of situation in our campus. We have to change this state. Think cleverly and effectively and choose the more successful personal mobility, a bicycle to satisfy the students campus commuting.

3. D. Life style of IIT Bombay students

As far as the IIT student are concerned, due to their busy academic schedule, most of them have no time to spend for any kind of physical activities. The unhealthy life style of the students can increase the risk of developing many health issues. High fat content food is one among them. The food supplied in IIT Bombay hostels contains lot of oil and fat. More over the students have a tendency to consume readymade or packaged food items. This lifestyle can invite cholesterol and other health risks very easily. Drinking and smoking habit can also invite cholesterol many respiratory and other health risks.

As a beginning we can start thinking about more healthy and sustainable way of living in side our campus. Campus commuting is an interesting area where we can make some successful changes towards this aim. But if we think about sustainable transportation, we may have to reduce or eliminate the motor vehicles from our campus. We can think about some non polluting mode of transport like human powered vehicles, electric or solar powered vehicles. A vehicle like cycle can satisfy these requirements and can offer a healthy and energetic life style for the campus population.

3. E. Why do we need a campus bicycle?

As I mentioned earlier the campus transportation systems have a lot of

limitations. Every year, with the increase in number students the effectiveness of campus tum-tum is getting reduced. In fact students are not happy with the current tum-tum service due to the early mentioned reasons. More over in recent years concern about exhaust emissions from motor vehicles has been increasing. Whole world is discussing about sustainable and green transportation. We have to rethink about the existence of these fossil fuelled vehicles in side our campus. Most of our tum-tum buses are running on CNG.

According to the security officials of IIT Bombay, around 5000 vehicles are coming in to our campus every day. The security officer said that at least 15 rickshaws are commuting inside our campus in day time, but in the evening this number can increase up to 20-25. We can not stop all the vehicles, because they are coming for various other purposes. But we can try to avoid the rickshaws from our campus, as they are making our students to catch them to travel even a small distance. Ultimately students will move away from their walking or cycling habit.

As far as the emission is concerned, CNG powered vehicles are creating the same order of pollution as those emitted by diesel vehicles. However, emissions of total hydrocarbons (THC) from CNG vehicles are relatively high because of methane, which is the major component of natural gas. Although methane is a small contributor to the formation of low level ozone it is a major factor in global warming.

As a solution to these problems, we should improve our non motorised commuting in side our campus by promoting walking and cycling. Many of the international universities have already implemented these system. In India , IISC Bangalore has introduced a Bicycle sharing system to develop a Green campus

Cycling and walking is the cheapest way than the electric or solar powered vehicles. More over these will be more affordable and acceptable for the students. As far as walking and cycling is concerned there are few advantage of cycling over walking. Cycling burns more calories per hour than walking and

cycling exercises the heart better than walking without the pounding of jogging. More over cycling is less time consuming than walking.

3. F. Cycling benefits

1. Cycling is one of the easiest ways to exercise.
2. Cycling is low-impact exercise that can be enjoyed by people of all ages.
3. Cycling is mainly an aerobic activity, which helps to activate heart and blood vessels.
4. Basically, a person who cycles regularly can expect, to live longer than those who don't.
5. Cycling can also give a high fitness level. The average daily cyclist has the fitness level of 10 years younger [3]

Health benefits

Cycling have lot of health benefits, they are

1. It builds strength and muscle tone 2.
2. Cycling improves general muscle function gradually.
3. Cycling builds stamina
4. Cycling helps to improve cardio-Vascular fitness.
5. Steady cycling burns approximately 300 calories per hour. Thus helps to reduce boy weight
6. Cycling can reduce stress and depression
7. Improves control of blood pressure
8. Trains respiratory muscles.
9. It will improve joint mobility.
10. Cycling improves whole body coordination.
11. Cycling reduces the chance of bowel or breast cancer. [4]

Other benefits

1. Bicycle usage has virtually No carbon footprint.
2. Cycling educes air pollution .
3. Bicycles increase mobility for those who don't have access to motor transport.
4. Cycling is the most energy efficient form of transportation ever invented.
5. Predictable commute time.
6. Easier and cheaper parking
7. Reduces the demand for new roads and pavements.
8. Cycling reduces energy consumption
9. Reduces noise pollution.
10. Reduces the road accidents.

11. Easy to vary the route while travelling.
12. Cycling is fun. [5]

3. G. Indian initiatives of campus cycling

Campus bicycles are not yet popular in Indian educational institutes. But few of our institutes have started some initiatives in this area, IISC Bangalore, Aligarh Muslim University and Indore University are the examples.

IISC Bangalore

Is the first top Indian institute which has implemented campus bicycling. In 2012 they started this bicycle sharing system called “Namma cycle” with 150 cycles. Their aim is to improve the public awareness about environmental friendly transport system for easy connectivity.

Aligarh Muslim University

In 1st August 2013, the Vice Chancellor Lt. Gen. (Retd.) Zameer Uddin Shah has launched drive to popularize cycling within their University campus. Before this, he banned all the motor cycles in all the hostels of the university. Their main objectives were to promote cycling as a healthy exercise. the hostels of the university.

Devi Ahilya University (DAVV)

The vice-chancellor DP Singh always supporting the use of non motorized vehicles in side the campus. For the promotion of bicycling inside the campus, he rode a bicycle himself with some of his guards for an induction programme of the new comers.

3. H. Bicycle industry

The study of bicycle industry gave the scope and various opportunities in this field. It was also helpful to understand the problems and trend which currently happening. The market forecast will be useful to judge the future of bicycle industry. happening.

Global industry

The global bicycle industry is expected to achieve moderate growth over the next five years. Rising fuel cost , growing congestion due to increasing population

and vehicles and growing fitness consciousness is expected to move the bicycle industry for the next five years.

Cycling is emerging as a short distance commuter which causing no pollution. Industry is also facing challenges like rising raw material cost, popularity of motor bikes and increasing demand. The various government schemes to promote cycling, act as a strong support for the industry.[6]

Indian industry

India is the second largest bicycle manufacture in the world with 15 million annual production. Around 3 million are exporting, which show the huge domestic demand. Hero Cycles, TI Cycles, Avon cycles and Atlas cycles are four key players in Indian bicycle industry having 90% market.

The market for the premium or the lifestyle bikes is just about emerging. The premium/high-end bicycles segment is growing at 24-28%. The definition of high end bicycles is keep on changing, earlier high-end bicycles were considered to be sold with in the price range of 5000 INR-8000 INR. Now with the intrusion of global brands have changed this values from around 15000 INR to as high as few lakhs.

The mass market segment is having a slow annual growth between 4%-6%. 90 out of 1,000 people in India own bicycles, compared with 149 out of every 1,000 in China and 400 out of every 1,000 in the US. According to All India Cycle Manufacturers' Association (AICMA) the price of a bicycle in India is twice that in countries such as Brazil and China. [7]

3. I. Bicycle brands in India

These are the major brands of bicycles available in India.

Hero

Hero Cycles Limited, based in Ludhiana Punjab, India, is a manufacturer of bicycles and bicycle related products. Founded: 1956. In 1986 Hero Cycles Limited entered the Guinness Books of World Records as the largest bicycle manufacturer in the world.

BSA

140 year old bran brand originated in UK. Since 1964 BSA was taken over by TI Cycles. BSA SLR in 1975,LadyBird 1994 are the most popular models from BSA [8]

Hercules

This brand was belonged to the former Hercules Cycle and Motor Company Limited was founded on 9 September, 1910 in Aston, England. In India the first Hercules bicycle launched in 1951. Hercules introduced bicycle shock absorbers for the first time in India in 1993. They introduced the geared mountain bike in India. Now the company is owned by TI Cycles.[9]

Atlas

This company was started by Shri Janki Das Kanpur in 1951 at Sonepat, Haryana. By 1965, Atlas had emerged as India's largest cycle manufacturer. The company has been exported its bicycles to around 35 courtiers so far.[10]

Avon

Started in 1951 by Avon Group, and Avon Cycles Limited is the flagship company of the group. The Head Office and manufacturing plant are located on the G.T. Road at Ludhiana. The company have about 2000 authorised dealers and more than 12,000 sub-dealers all around India.[11]

Firefox

The company was started in 2005 with an imported range of approximately 30 bike models into the Indian market. Presently the company have 70 models with the wide spectrum of mountain, all-terrain, road, BMX & kids bikes. They have 8company owned outlets and more than 100 franchisees all over India. In June 2006 Firefox teamed up with Trek Bicycle Corp., USA, for exclusive distribution of Trek in India[12].

Montra

Is a part flagship range of TI Cycles, introduced the first indigenously designed and manufactured Carbon frame bicycles with international quality.

Montra cycles are faster, lighter and stronger than any cycle ever created in India [13].

Cannondale

Cannondale Bicycle Corporation, is an American division of Canadian business group Dorel Industries that supplies bicycles. Founded in 1971, with its headquarters is at Bethel, CT, USA. Track and Trail is the leading importer of the bikes in India.

La Sovereign

La Sovereign is a first ever joint venture between Thailand & India Based companies to market Bicycle & Kids Toys of superior quality. Sovereign is an India based company & have been in the Bicycle trade for the last 40 years. La Thailand is a Thai company manufacturing Bicycles, Toys & Electric Vehicles for Asian, European & American Market[14].

Schnell

Is a part of Goldie Group operating in the area of bicycle industry since 1960. The company have the complete range in MTB, FSX, Road, Hybrid and Kidd etc[15]

Fuji

Originally founded as a Japanese bicycle manufacturing company (Nichibei Trading) in 1899. Fuji expanded to the United states market in 1970s. In 1998, ASI(Advanced Sports International) purchased Fuji.

Bianchi

Bianchi is a 127 year old Italian bicycle manufacturer, which was started by Eduardo Bianchi in Milan, Via No one in 1885. . In India, Bianchi are being distributed and managed by T I Cycles of India, under their umbrella brand for performance bikes, ‘Track & Trail’.

Rock Riders & Btwin

Comes under Decathlon group, which is a major French sporting goods chain store, with stores located throughout the world. It started with a shop near Lille, France in 1976. Not well established in India but it’s market is emerging.

Merida

Is a German engineered bicycle with Taiwanese manufacturing. Today Merida has over 70 international Merida distributors worldwide.

Trek

Trek Bicycle Corporation is a major bicycle and cycling product manufacturer and distributor. The company is founded in 1976 with, its headquarters in Waterloo. Firefox is the leading importer of Trek bicycles in India.

[IR 1]

3. J. Types of bicycles

Bicycles can be classified according to various factors, they are

1. By function
2. By sport
3. By frame design
4. By material
5. By rider position

But here I am going to mention only the. major classification of the cycles . It covering almost all categories of function, frame design rider position etc.

Road bicycles

Bicycles built for traveling on paved roads. Compared to other styles of bicycle, road bicycles have features:

- Narrow , high-pressure, and smooth tires to decrease rolling resistance.
- They have a curvy handle bar.
- The bicycle is of a lightweight construction.
- They don't have suspension.
- Rider will be more closer to top tube.

[IR 2]

Mountain Terrain Bike (MTB)

Is a bicycle for off-road cycling. Mountain bikes are typically used on rocks, washouts, loose sand, loose gravel, roots, and steep grades. Mountain bike construction differs from a typical bicycle in many ways Suspension on the frame and fork.

- More durable heavy duty wheels
- More powerful brakes.
- More upright riding position.

[IR 3]

Commuter bicycles

Designed for city or streets uses. Urban bikes are rugged and sturdy with tough frames and strong wheels. They feature an upright riding position .

[IR 4]

Cruiser bicycles

A cruiser bicycle, is a bicycle which combines balloon tires, an upright seating posture, a single-speed drivetrain, and straightforward steel construction with expressive styling. They are very stable and easy to ride, but their heavy weight and balloon tires tend to make them rather slow[16]. Most of have a classic "retro" looks and relatively low price compared to mountain bikes or road racers.

[IR 5]

Touring bicycles

Bicycle designed or modified for bicycle touring. This bicycles are v very, comfortable and capable of carrying heavy loads. They have long wheelbase for ride comfort and to avoid pedal-to-

[IR 6]

Luggage conflicts, frame materials that favour flexibility over rigidity for ride comfort, heavy duty wheels(for load capacity, and multiple mounting points for luggage racks, fenders, and bottle cages.

BMX Bicycles

"BMX" is the abbreviation for bicycle motocross. This kind of bicycle is used for both casual riding and sport, and designed mainly for dirt and motocross cycling.

[IR 7]

They are usually smaller compared to the other bicycles and don't have gears[17]

Triathlon Bicycles

They are bikes with a special aero-dynamic design. It's special curvy and

[IR 8]

aerodynamic handle bar design allows to lean forward while riding, to minimize the wind resistance against the body. They have usually deep rim or disk wheels.

Hybrid Bicycles

They combines the features of both road bikes and mountain bikes. Having lightweight components, often includes mudguards and slick or semi-slick tyres. They have a comfortable seat, upright sitting position and (often) suspension forks, they have 700-millimeter (700c) wheels for efficient ride.

are very popular among beginning cyclists, casual riders, and children

[IR 9]

They are usually smaller compared to the other bicycles and don't have gear.

Tandem Bicycles

The tandem bicycle or twin is a form of bicycle designed to be ridden by more

[IR 10]

than one person. The term tandem refers to the seating arrangement not the number of riders[18].

Recumbent Bicycles

A recumbent bicycle is a bicycle that places the rider in a laid-back reclining position.

[IR 11]

The rider's weight is distributed comfortably over a larger area, supported by back and buttocks. Most recumbent models have a legs-forward position of the rider's body, presents a smaller frontal profile. They are more difficult to pedal up hills[19].

Electric assist bicycles

An electric bicycle, or an e-bike, is a bicycle with an integrated electric motor which can be used for propulsion. They

use rechargeable batteries and the lighter varieties can travel up to 25 to 32 km/h depending on the laws of the country in

[IR 12]

which they are sold, while the more high-powered varieties can often do in excess of 45 km/h[20].

Foldable bicycles

A folding bicycle is a bicycle designed to fold into a compact form, facilitating transport and storage. When folded, the bikes can be more easily carried into buildings and workplaces or on public transportation, and more easily stored in compact living quarters or aboard our vehicles. Because of the complexities of their folding mechanism, more demanding structural requirements and greater number of parts, folding bikes may be more expensive than comparable non-folding models [21].

[IR 13]

4. Market analysis

Before the design process I have done a market analysis, which helped me to understand the purchase trend of the particular user group. The market analysis comprised of detailed discussion and a questionnaire survey with the bicycle dealers. For this analysis , I have selected two different kinds of dealers, one dealer is located in a shopping mall environment and the other is in the town area. First shop was Sports XS, located in R-City mall, Ghatkoper, Mumbai. The second shop was " A one ", Powai, Mumbai.

4. A. Questionnaire survey & interview

The questionnaire consist of 14 questions, they are given as

Question 1: What are the different types of bicycles available?
A. Mountain terrain bikes, Street bike according to use. Man, unisex and women bicycles.

Question 2: Which factors have the most preference?:
A. Brand , prize ,weight

Question 3: What is the price range available with you?
A. 1. Sport XS shop – 5000 INR TO 50000 INR.
2. Aone shop – 3700 INR to 16000 INR

Question 4: Which brands are available with you?
A. 1. Sport XS shop- Firefox, Decathlon, BTwin, Rockrider, Cannondale, Bianchi, Merida, Schwin
2. Aone shop- Hero, Hercules, BSA, Avon, Action

Question 5: Which brand has the most demand, why?
A. 1. Sport XS shop - Firefox, Cheaper compered to other brands and also have the similar features.
2. Aone shop- Hero Razorback, Good design, handle adjustable, Unisex, smooth riding.

Question 6: Which type of cycle has the maximum demand?
A. MTB, due to the appearance and its good for rough roads in Mumbai.

Question 7: Which are the favourite colours of the students?
A. Black, red, blue, or dark colours for

boys . And white ,pink or any light colour for girls

Question 8: Is there any demand for the accessories?
A. Not much. In both shops.
SportXS : "*Customers have to buy the accessories like pedal, seat cover, stand, bell etc approx.3000 Rs*".

Question 9: Are the students are looking for storage space, for tools and other facilities?
A. Not much, but sometimes for tools.

Question 10: What do you think, have the most influence on the students while buying a bicycle?
A. Friends, media, Internet…

Question 11: What are the different sizes available for college students?
A. 24" Small sized, 26" Medium sized and , 28" Large sized. and ,

Question 12: What factors will affect the size selection?

A. Physical factors like height.

Question 13: What are the new purchase trends in bicycle? why?

A. 1. SportXS : More demand for foreign cycles. As mentioned early due to quality, design and better design.
2. Aone shop : More demand for MTB models with gear.

Question 14: Average monthly Bicycle sale?
A. SportXS : 6-7 cycles, Aone shop : 30 cycles

Inference from market analysis?

1. More demand for MTBs.

2. No need of additional accessories.

3. More demand for brand and weight

5. User Study

The user study was intended to understand the various user requirements and trends. My selected users were the students of IIT Bombay. Their usual travel will be from their hostels to the college and voice versa. In order to get a collective result, this study tried to cover the male as well as female students. The user study included a questionnaire survey both quantitative as well as qualitative, a detailed discussion with the user and thorough observation of the cycle users and the various cycling related aspects.

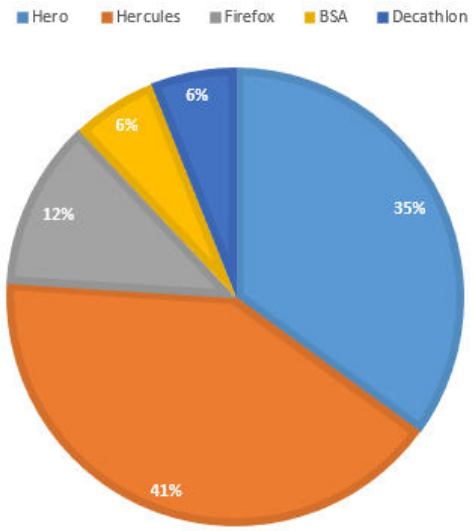
5. A. Questionnaire survey

For questionnaire survey, I have selected two type of people, present users and potential users. Number of respondents were 30 and number of questions were 14. The questions are given below.

Question 1: Which cycle do you have?

This question was indented to get an idea about which kind of cycle they are using. That will give some clues about the purchasing trend of students.

Total respondents =17



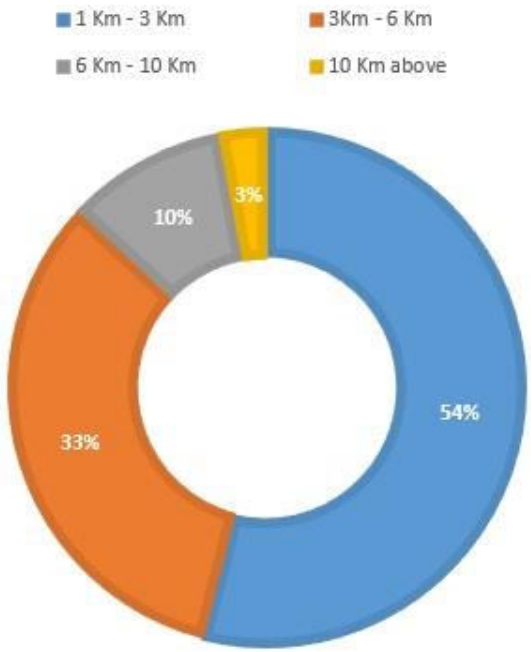
Question 2: Are you planning to buy a bicycle?
This question will give ones expectation of student who wants to buy a cycle.
Total respondents – 13
Yes = 10 Nos
No = 3 Nos

Question 3: What do you like about your current cycle
Total respondents = 17

Main key words obtained are
Comfort, Light weight

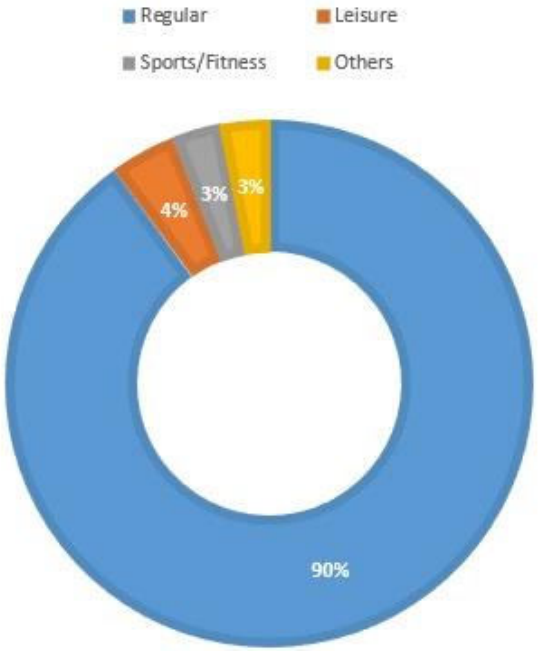
Question 4: What you don't like in your current cycle?
Total no of respondents = 1
Main key words obtained are
Lack of gear, Over usage of graphics, Rusting, Lack of mud guard

Question 5: Average daily travel distance in campus?
This question will help to understand the average travel distance of a student in the campus.
Total number of respondents = 30



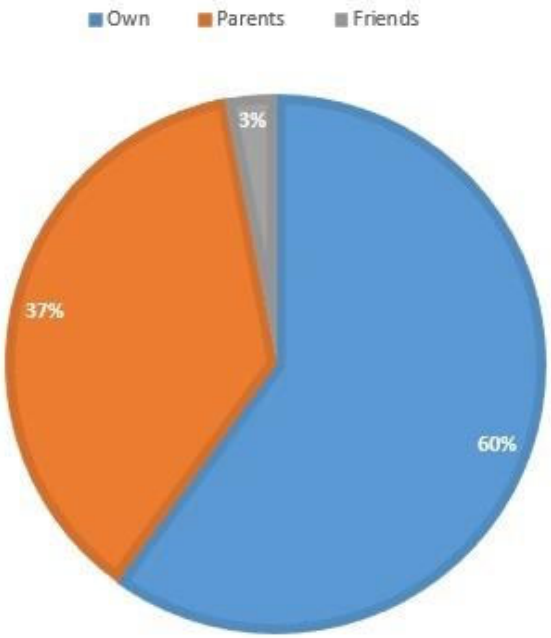
Question 6: For which purpose do you use the cycle the most? or For which purpose do you plan to use the cycle the most?

This question will lead to the usage trend of students.
Total number of respondents = 30



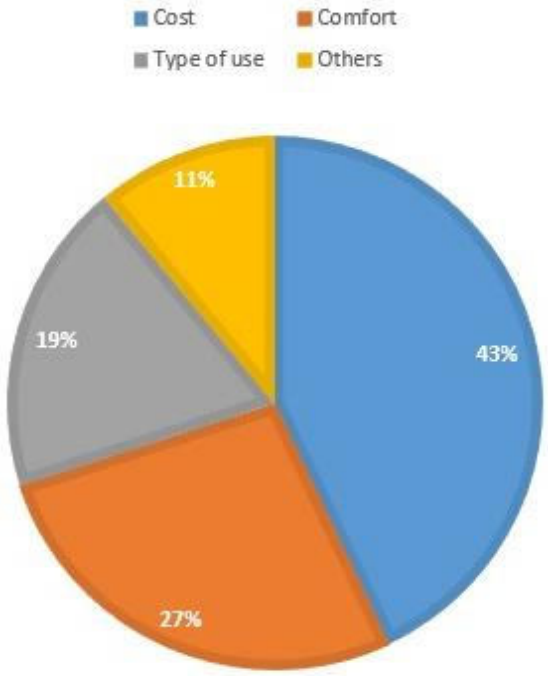
Question 7: Who financed for the cycle or Who would finance for the cycle?

This, question will give the income source, which is an important factor in the purchase.
Total number of respondents = 30



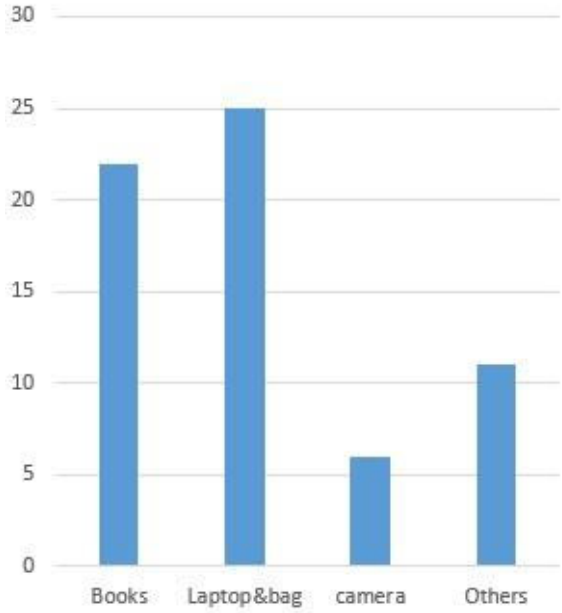
Question 8: Which factor did you consider while buying the cycle? or Which factor will you consider while buying a cycle? Total respondents = 30

Total respondents = 30



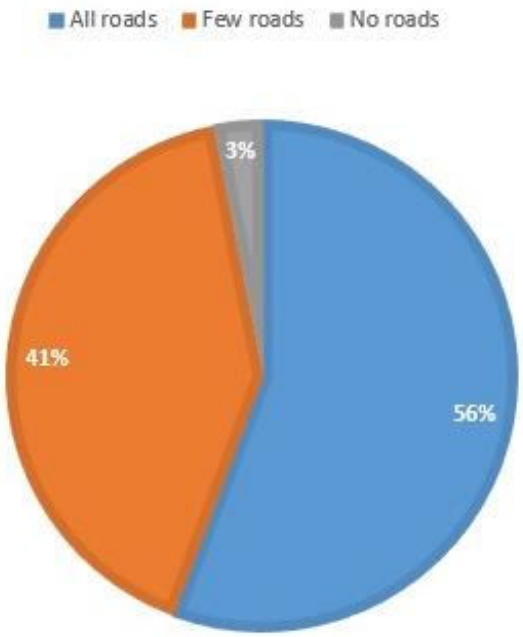
Question 9: What all things do you carry along with you in campus?

Total no of respondents = 31



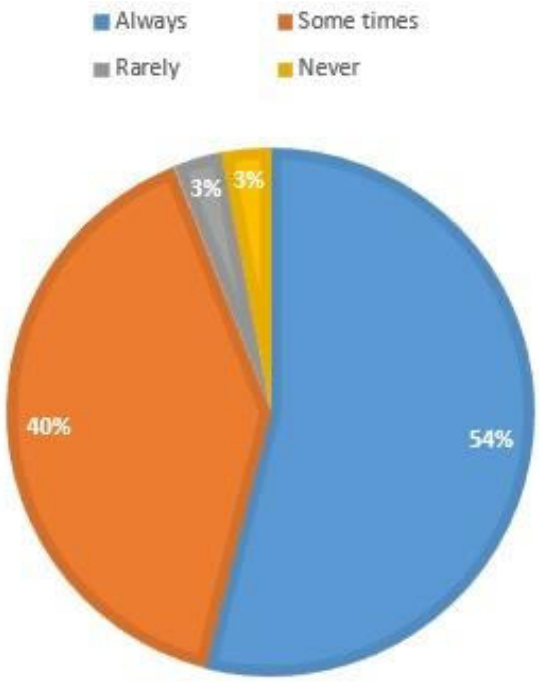
Question 10: Do you feel IIT Bombay campus roads are comfortable for cycling?

Total no of respondents = 32



Question 11: Do you use cycle in the night? Or Do you need cycle in the night?

Total no of respondents = 33



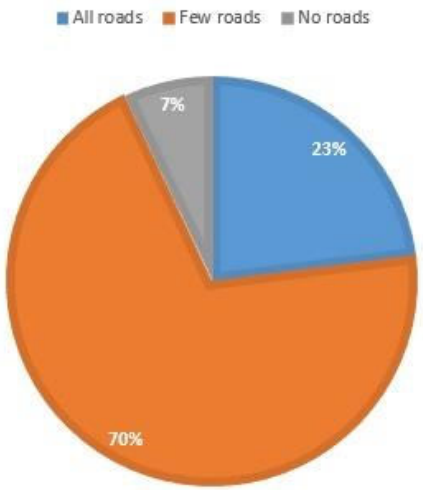
Question 12: Which is your favourite cycle? Why?

Total respondents = 25

Favourite cycles are
Fire fox – light weight, sleek, trendy, geared
Hercules – Comfort, light weight
Trek, decathlon – MTB, Light weight, trendy, geared

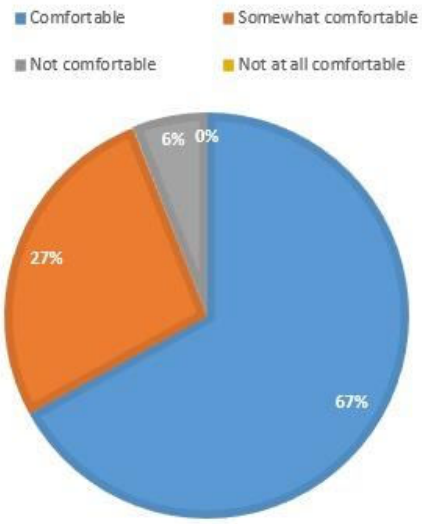
questionair: 13 Do IIT Bombay campus roads are well lit in the night?

Total no of respondents = 30



Question 14: Are you comfortable to carry back bag while cycling

No of respondents = 30



Inferences from questionnaire survey

- Almost all students have Mountain Terrain Bicycles

- Average daily travel distance in the Campus is between 1 Km to 6Kms

- The main purpose of cycle is the regular commuting in side the campus

- Almost 60% of students are using their own money, either stipend or account deposited during their previous work time.

- Cost and comfort got maximum priority
Cost – 45%, Comfort – 27%

- Most of the students like light weight bicycle.

- They like to have geared bicycles

- They don't like over graphics

- They are facing rusting problem in most of their bicycles, need of an anti rusting material.

- Most of the students are comfortable in carrying a back pack while cycling. 67% comfortable, 27% somewhat comfortable , 6% not comfortable.

5. B. Unexpressed needs through observation

The various bicycle users were thoroughly observed and inferences have noted. In this study I tried to understand the various needs of the users which they might forgot or could not express in the questionnaire survey or in interview.

Inferences from observation

- Every one using a back bag
- Very little usage of carrier
- Only few students have co-passenger
- No additional items were carried except few were carrying umbrella on the carrier and a girl used the basket of cycle to keep her bag

Inferences from observation

- Most of the cycles have mud guard
- Almost all cycles are of mountain bike type.
- Over graphics.

Inferences from observation

- Many parts are not looking as an integral part of the bicycle design.
- Big structural tubes add more visual mass to the bicycle.
- Poor welding and painting finish.

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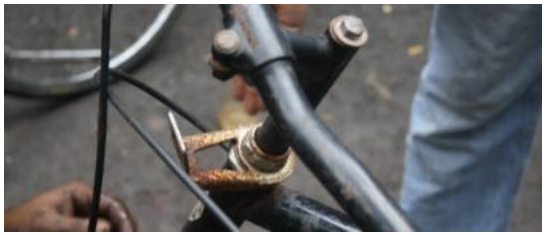
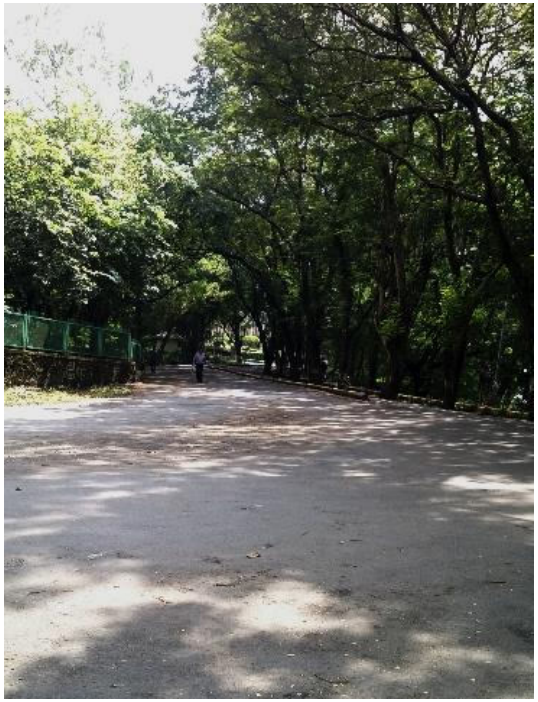


Inferences from observation

- The painted or plated parts are rusted.
- Easy damage of steel cycle tubes.
- Mud guard and rim are more prone to rusting.



The road from gymkhana building to SOM has a very long slope. This will make the cycling slightly difficult. This road is the main road from the hostels to the academic area, so this road slope is of great importance while designing the campus bicycle

The connecting hill side road and NCC ground road via. Hydraulics lab is also very long and steep. Cycling with out gear is very difficult through this road.

The road going towards central library from the main road near to NCC ground is also have high slope.

Pic : D, Sameer hill side road is having the steepest and longest slope. The student from Hostel 15 are cycling through this road towards the academic area. Cycle with out gear cant climb this road.

Inferences from observation

- Many roads of IIT Bombay has comparatively higher slopes making it difficult for normal cycling.

- Most of the campus roads are well paved and in good condition, offering good surface for comfortable riding.

6. Trend study

This study tried to cover the ongoing trend in this segment of bicycles around the globe. Campus bicycles in India as well as abroad have taken in to consideration. The study gave some insights about the real world application of campus bicycles.

6. A. Trend study abroad

The various Universities of America, Europe Asia and other part of the world have already implemented this system, and are successfully running.

Western Carolina University, University of Missouri, University of Pennsylvania are the few of the universities in United States have introduced running campus bicycles successfully. University of Calgary, Canada is another example for this. The University of Cambridge, Sunderland University, National University of Ireland, Yale University are few examples from Europe.

Konkuk University Seoul has also introduces campus bicycles and represents Asia among these group. Corporate giants like Google's also implement a bicycle sharing system in Mountain View campus, California.

Yellow bicycles, Western Carolina University. [IR 14]

Rental bicycles at University of Missouri [IR 15]

Yale University, United States
[IR16]

National University of Ireland, Galway
[IR 17]

Sunderland University, UK [IR 18]

Konkuk University, Seoul [1R 19]

Google Campus Bike , California, USA [IR 20]road

6.B. Trend study India

Namma cycle, IISC Bangalore, India [IR 21]

In India the concept of a campus bicycle is very new. We don't have any background of a typical campus bicycle, even though many students are using bicycles in the campuses. IISC Bangalore have started initial attempt with 150 bicycles called Namma Cycle in 2012. This is the first campus bicycle sharing system started by an Indian Institute.

Inferences from trend study

- Mostly unisex bicycles, enables common usage of boys and girls.
- Bright coloured, ensures better visibility.
- Some kind of carriage system, helps the students to carry their goods.
- Road type of bicycles, since the campus roads provide comparatively levelled surface
- Minimalistic designs, ensures cost reduction and easy maintenance

7. Technology study

This study is intended to understand the various technologies applied in the bicycle industry. This study will help to utilize the resources in a more effective way. This study mainly covered the directions came out in the design brief, that helped me to select the suitable solution for the final design. The major topics are given below.

- Bicycle parts
- Materials and properties
- Bicycle gearing

7. A. Bicycle parts

A bicycle is very simple in design. Almost all parts of the bicycle are visible to the eyes. The most basic bicycle parts are a frame, the wheels, the pedals, the handle-bar and a chain and sprocket arrangement to transmit power from the pedal shaft to the rear-wheel shaft. Advancements in technology by the 1990s led to the use of lighter and stronger materials in the bicycle industry.

1. Frame

The frame is the backbone of a bicycle generally consist of metallic tubes connected together. All the other parts are attached to this frame. Thus the frame performs the function of holding together all the parts together and keeping the whole vehicle steady. A bicycle frame generally consist of

- Top tube
- Down tube
- Seat tube
- Seat post
- Seat stay
- Chain stay
- Head tube

Top tube
Is a frame member leading from head tube to the seat post[22].

Down tube
It is the tube that runs from the head tube to the bottom bracket of a bicycle frame[22].

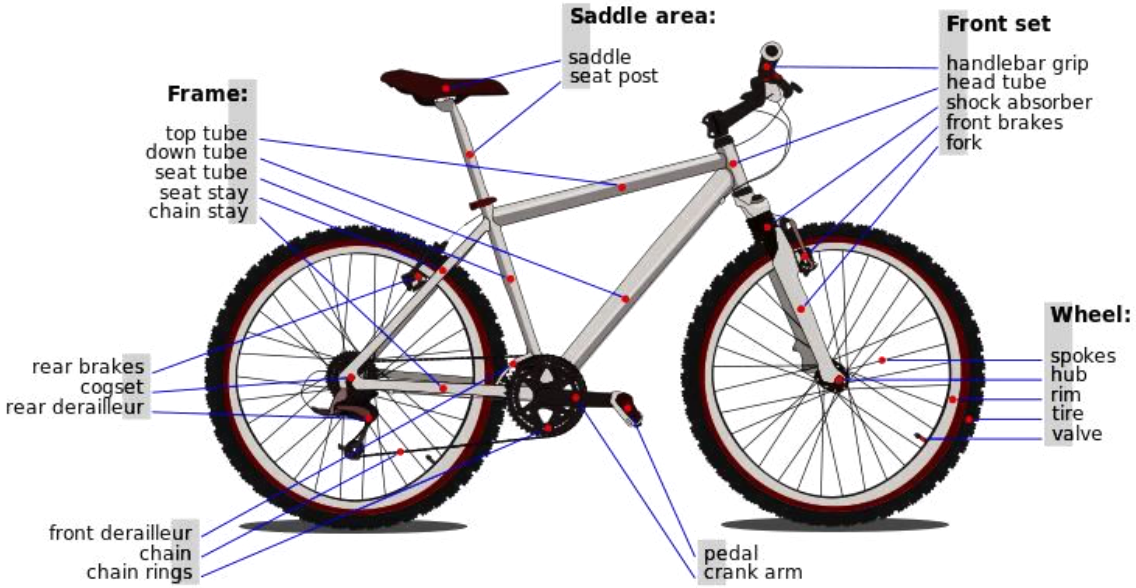
Seat post
It is the roughly vertical tube in a bicycle frame running from the seat to the bottom bracket [22].

Seat stay
Are the small diameter tubes running

from top of seat tube to rear dropouts[22].

Chain stay
A pair of tubes on a bicycle frame that runs from the bottom bracket to the rear fork ends[22].

Head tube
The tube of a bicycle frame that contains the headset[22].



Bicycle parts[IR 22]

2. Fork

It is a mechanical assembly that integrates a bicycle's frame to its front wheel and handlebars, allowing steering by virtue of its head tube[22].

3. Wheels.

The wheels are the important parts of a bicycle which help to move the cycle and. The front wheel is attached to the front fork which is already attached to the frame and the rear wheel is connected to a shaft with an attached sprocket which ultimately connect the wheel assembly to the frame. The main parts of the wheel are

- Rim
- Spokes
- Hub
- Tire
- Valve

Rim
Is the solid circular part of a wheel to which the tire is attached and it also helps for the breaking mechanism.

Spokes
Are the wires which connects wheel rim to hub. Usually wire with one end swaged to form a head and one threaded end. A typical wheel has 36 spokes.

Hub
Is the core part of a wheel; contains bearings and, which helps to attach the wheel to the fork. The hub ensures the smooth rolling of the wheels.

Tire
Is usually a rubber attachment provided around the rim to give comfort while travelling. The tires need to be inflated with help of rubber tubes, which generally kept inside the tires.

Valve
Is the port through which air can be filled or released from the inner tube.

4. Pedals

The pedals helps to transmit the human effort through respective crank set onto a shaft. This shaft revolves within the hollow bottom bracket frame of the bicycle. The crank set consist of a crank and chain ring.

7. B. Materials and properties

Bicycle industry generally used Steel and steel alloys to make the frames. Frame material was continually improved to increase strength, rigidity, lightness and durability. The 1970s witnessed the introduction of more versatile steel alloys which could be welded mechanically, there by increasing the availability of light and inexpensive frames. During the next decade more light weight aluminium have introduced. By 1990s even lighter and stronger materials like composites of structural fibres such as carbon have emerged, which helped to produce high quality bicycle frames. In addition to these materials few other materials like TeXtreme Spread Tow carbon fabrics , Chromoly , bamboo are also using in the industry. Recently in 2012 a cardboard bike was also introduced.

1. Carbon (High-Tensile) Steel

Steel is the most commonly used material in bike frames. Carbon or high-tensile steel is a good, strong, long-lasting steel, but it is not very light in weight compared to the aluminium alloys or carbon fibre[23].

2. Chromoly (Chrome Molybdenum) Steel ,

It's an steel alloy containing chromium and molybdenum. Chromoly (CrMo) is commonly used to make high-end bicycle frames, roll cages for race cars, and for fuselages on small aircraft [24]. Chromoly and High tensile steels weigh virtually the same but CrMo is stronger which means that we can use less material and maintain strength. Chromoly bends before it breaks.

3. Aluminium alloys

Aluminium alloys have lower density and strength compared with steel alloys, and they have better strength to weight ratio. This feature making aluminium alloys lighter than the steel alloys.

4. Titanium

Titanium is the strongest metal on the periodic table and is lighter than steel,

and is commonly used for making high-end road or cross-country mountain bikes. Its capacity to maintaining the shape allow this metal to use itself as a shock absorber.

6. Carbon fibre

Carbon-fibre-reinforced polymer or simply carbon fibre , is an extremely strong and light fibre-reinforced polymer which contains carbon fibres. These fibres are bounded by epoxy polymer, but other polymers, such as polyester, vinyl ester or nylon, are sometimes used. Carbon fibre is expensive, light-weight, corrosion-resistant and strong, and can be formed into almost all desired shapes.

7. Bamboo

Bamboo has good tensile strength and tubular structure. Bamboo frames are lighter and stronger than poor quality steel bicycles. It is eco-friendly also. Using Bamboo also cuts down the energy consumption as compared to steel, aluminium, titanium and carbon fibre. Bamboo has better shock- absorbing power for rough roads.

8. Wood

Wooden bicycle frame is not very common and is either solid or laminate. Wood is a sustainable building material than steel or carbon or aluminium. wood can withstand impact greater than carbon or steel.

9. Cardboard

Cardboard bike was created by Israeli inventor Izhar Gafni, in 2012 who bends and folds pieces of recycled cardboard into strong, weight-bearing shapes.These bikes will be durable, fire- and water-resistant, and able to carry up to 180 kilograms.

10. Thermoplastic

Thermoplastics are a category of polymers that which be reheated and reshaped, and there are several ways that they can be used to create a bicycle frame. One application is with carbon fibre to make bicycle frames with the fibres embedded . in a thermoplastic material rather than the more common thermosetting epoxy materials.

GT Bicycles was the first manufacture came up with a thermoplastic frame in the mid 1990s.

11. Magnesium

Few of bicycle frames are made from magnesium which has around 64% the density of aluminium. In the 1980s, an engineer, Frank Kirk, devised a novel form of frame that was die reliability and manufacture stopped in cast in one piece and composed of I beams rather than tubes. 1992. The small number of modern magnesium frames in production are constructed conventionally using tubes.

12. Combinations

The combination of different material can offer better structural as well as functional benefits than that given by a single material. The combined materials are usually carbon fibre and a metal, either steel, aluminium, or titanium

7. C. Bicycle gearing

Bicycle gearing is the aspect of a bicycle drivetrain that determines the rate at which the rider pedals, and the rate at which the drive wheel turns. Many contemporary bicycles have multiple gears and thus multiple gear ratios. A shifting mechanism allows selection of the appropriate gear ratio for efficiency or comfort under the prevailing circumstances [25]. There are two main types of gear change mechanisms, known as derailleurs and hub gears.

1. Derailleur gears(External gears)

External gearing is so called because all the sprockets involved are readily visible. There may be up to 3 chain rings attached to the crank set and pedals, and typically between 5 and 11 sprockets making up the cog set attached to the rear wheel. Modern front and rear derailleurs typically consist of a moveable chain-guide that is operated remotely by a Bowden cable attached to a shifter mounted on the down tube, handlebar stem, or handlebar. When

a rider operates the shifter while pedalling, the change in cable tension moves the chain-guide from side to side, "derailing" the chain onto different sprockets. The rear derailleur also has spring-mounted jockey wheels which take up any slack in the chain[25].

11. Hub gear (Internal gear)

Internal gearing is so called because all the gears involved are hidden within a wheel hub. Hub gears work using internal planetary, or epi cyclic, gearing which alters the speed of the hub casing and wheel relative to the speed of the drive sprocket. They have just a single chain ring and a single rear sprocket, almost always with a straight chain path between the two. Hub gears are available with between 2 and 14 speeds. Hub gearing is often used for bicycles intended for city-riding and commuting. Hub gear mechanism is more complex and expensive than the derailleur mechanism[25].

8. Reference for bicycle dimensions

BSA Mach-City [IR 23]

BSA LadyBird [IR 24]

8. A. Reasons for selecting these bicycles

- BSA is a very popular and widely accepted bicycle brand in India especially among youngsters.

- BSA Mac-City is very popular among college students, even in IIT Bombay. And BSA Ladybird is more popular among young girls.

- BSA Mac-City is a hybrid bicycle having the features of both mountain bike as well as road bike. My bicycle is also having mixed features of

- Since my bicycle is a unisex one, I have to give comfort for both boys and girls, so a comparison study will give better result.

- Both the cycles have sleek design

- Both of them have upright riding position.

- Both of them have simple tubular structure.

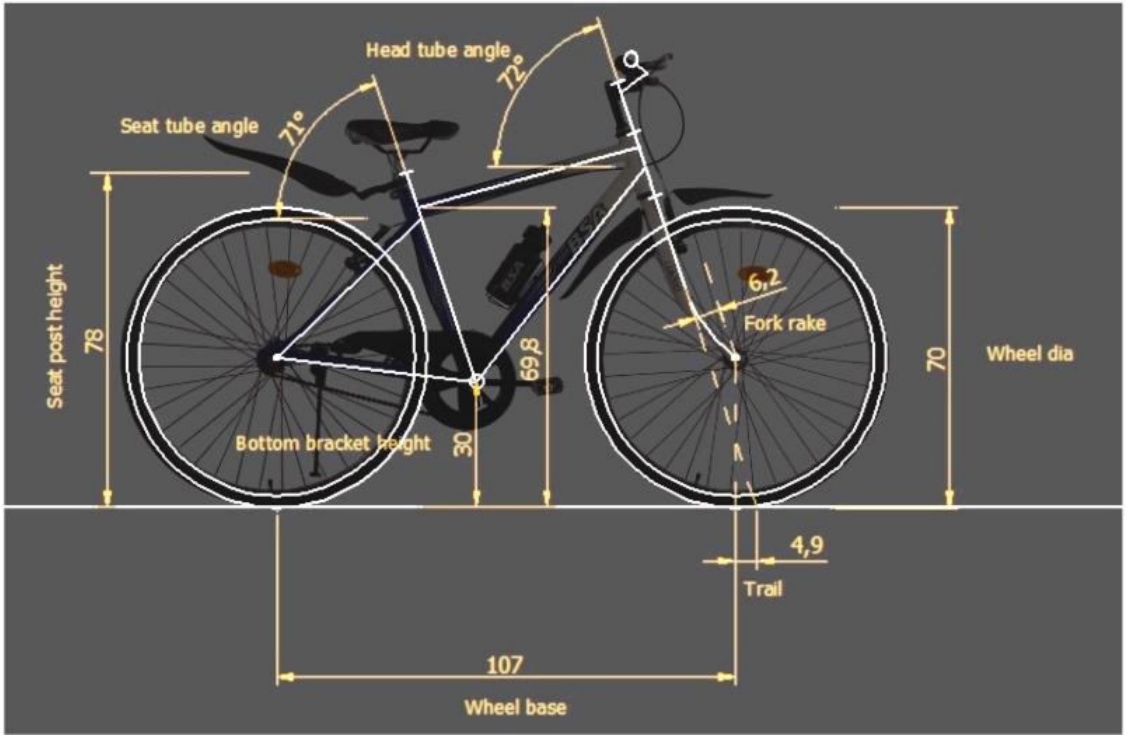
8. B. Dimensions of selected reference bicycle 1

All dimensions are in cm

BSA Lady Bird

8. B. Dimensions of selected reference bicycle 2

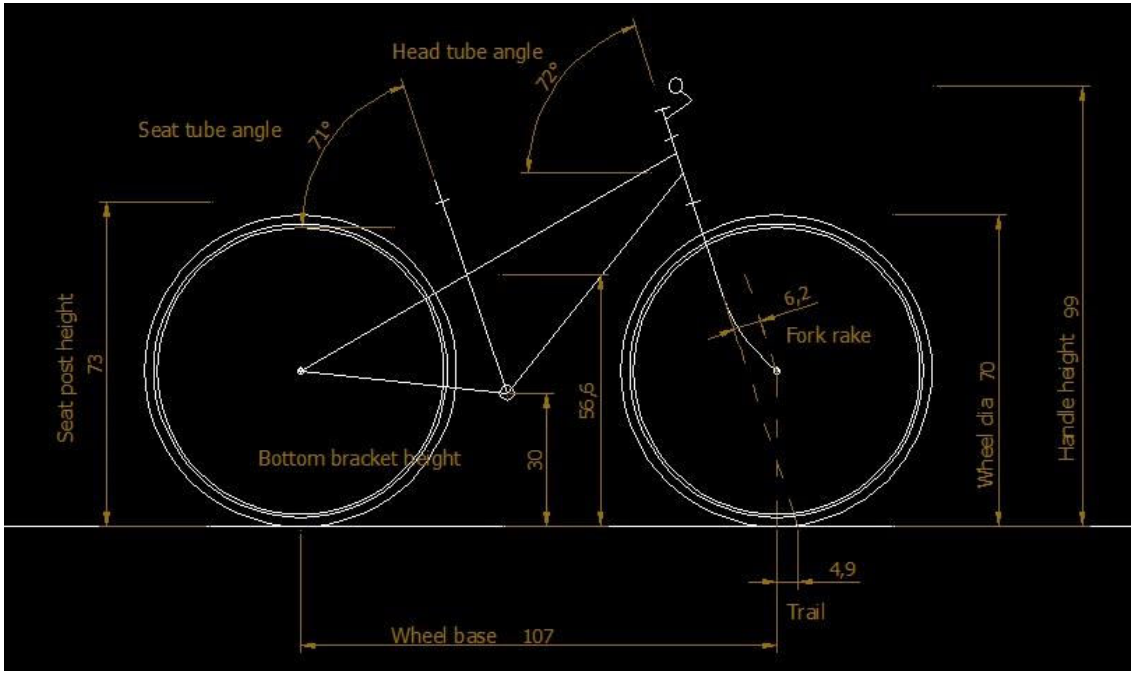
All dimensions are in cm



BSA Mach City

8. C. Final concept layout

All dimensions are in cm



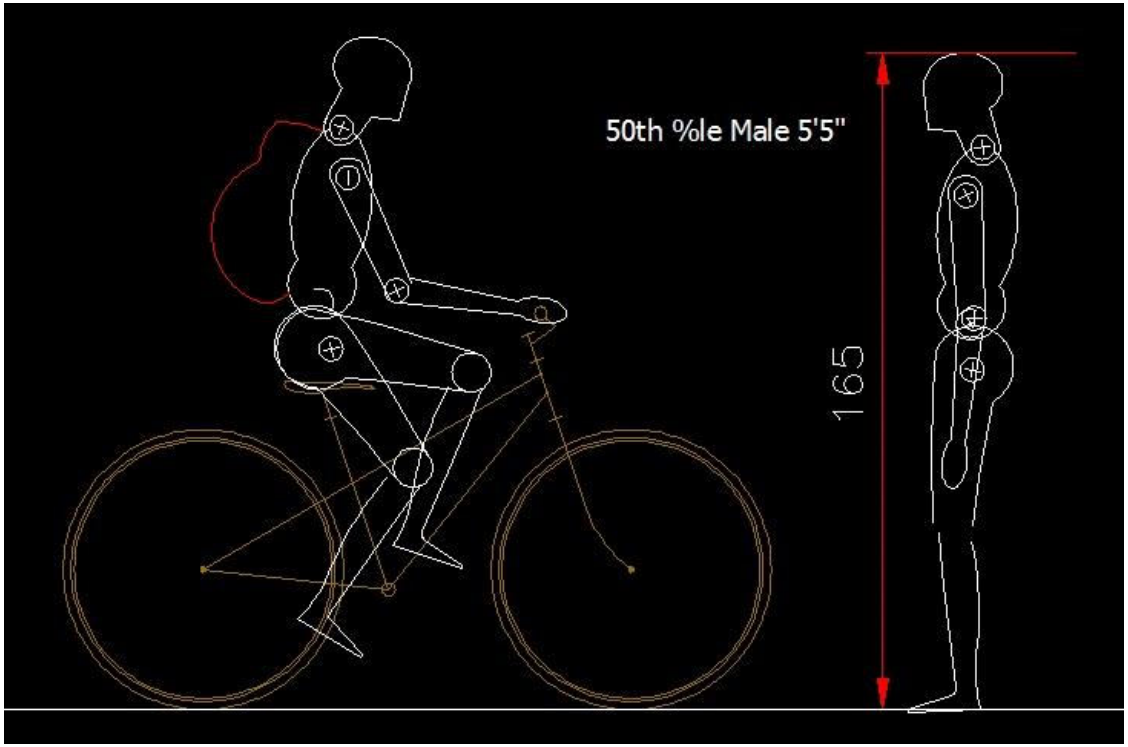
In the final layout I wheel base, bottom bracket height, head tube angle seat post angle, fork rake and trail kept the same as in BSA Mach-City in order to keep the hybrid nature and to get the comfort riding. But the top tube and seat stay are aligned in the same line, in order to make the design unisex as well as more dynamic Seat post height is according to the BSA Lady Bird in order to give comfort for girls. The handle height is selected proportionately according to the seat post height.

8. D. Manikin study - Male

For the final design I am considering only the 50th %le community. The upright sitting position will give more comfort for the students while cycling with their back pack. The inclination of the top tube has given almost an average value of the reference bicycles which will make sure the easy climbing up and climbing down by both male as well as female users.

- Average Indian male height 165 cm [26]

All dimensions are in cm

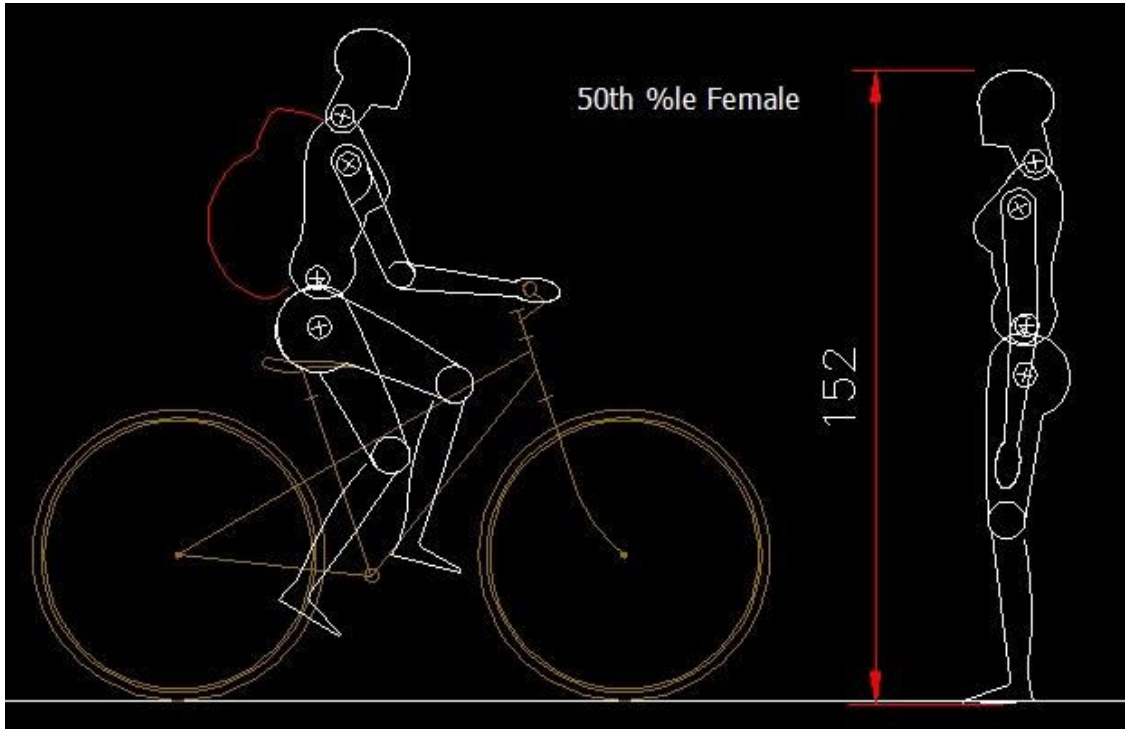


8. D. Manikin study- Female

As my design is a unisex one, the comfort of female users are also very important. Since the wheel base and other critical angles are same, only the seat post and top tube inclination will be different in the reference bicycles. In order to make the easy climbing the top tube inclination is taken lower than that in the BSA Mach city, but in order to retain the design theme this inclination is taken in between that of BSA Mach city and BSA Ladybird. For having comfortable sitting the seat post height is taken as that of BSA Ladybird (73 cm).

- Average Indian female height 152 cm [26]

All dimensions are in cm



9. Design brief

Styling

- Students like to have the sturdy and dynamic nature of the mountain bicycle although sleek and lightweight nature of road bicycles.

- Students likes minimalistic design.

- The bicycle should have the vibrancy in campus environment.

Functional requirements

- This bicycle have night time use.

- The bicycle should have the features to prevent Splashing from the wheels during monsoon.

- Students are comfortable to carry the back packs of average weight 5kg during their short distance campus travelling but they need some kind of carrier for things other than laptops, books and cameras.

- Students likes to have a cost effective bicycle.

Dimensional specification

- Wheel base – 107 cm
- Seat post height – 73 cm
- Handle height – 99 cm
- Trail – 4.94 cm
- Fork rake – 6.17 cm
- Head tube angle – 72 degree
- Seat post angle – 71 degree
- Wheel dia – 700 mm

Material specification

- Frame will be having aluminium due to its light weight, anti rusting property and resale value
- UV treated Poly propylene will be using for the mud guard and chain

Finish

- Considering the recent trend and for having better visibility fluorescent colours are using.

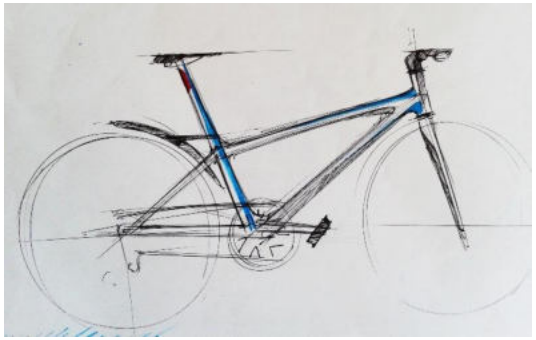
10. Mood board for styling

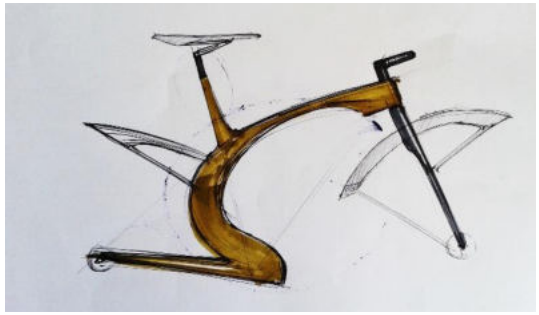
Vibrant

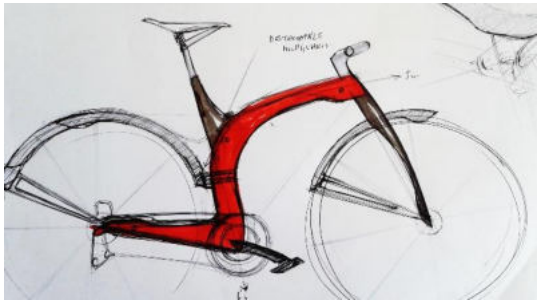
Dynamic

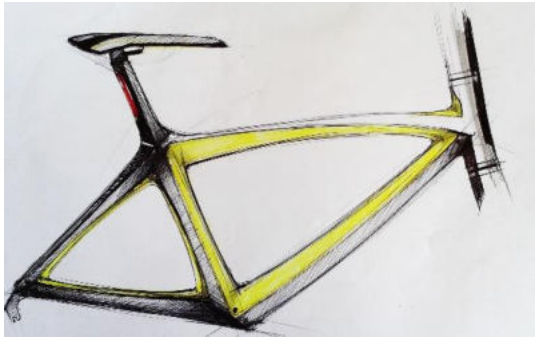
Sleek

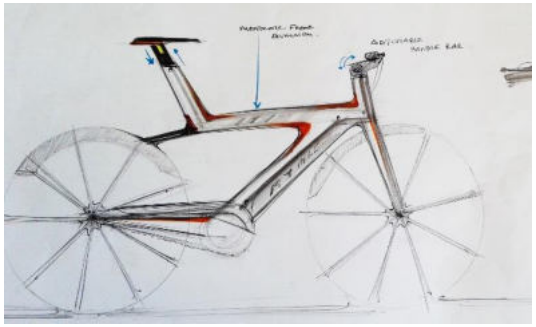
11. Ideations







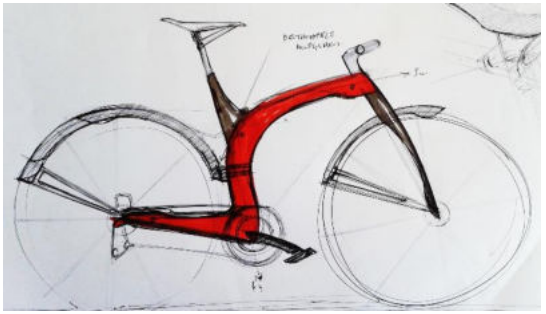









12. Shortlisted concepts



Reasons for selecting these bicycles

- Minimalistic design.
- Visually light.
- More dynamic designs.
- Scope to make it as unisex.
- Simple design except the 3rd one.
- Unique designs.
- Personal choice.

Concepts refined

13. User evaluation

The refined concepts were put for a user evaluation to select the final concept. 20 different users were selected for use evaluation and they have opted their favourite design according to the 7 given key words. These key words were selected from the design. During user evaluation, all concepts were converted in to the same colour in order to avoid the biasing towards particular colours. The users graded the keywords in points out of ten, and each keyword have given certain weightage according to the priority in the design brief. Finally the points of each keywords of each concepts were multiplied by the given weightage, and the concept 3 with maximum points of 13620 have selected as my final concept. The selected key words are

- Light/sleek
- Unisex-ness
- Minimalistic
- Dynamic
- Vibrant
- Fresh
- Campus-ness.

Concept 1 (C1) Concept 2 (C2) Concept 3 (C3) Concept 4 (C4)

User evaluation result

Parameter	Weightage	C1	C2	C3	C4
Light	20	2120	2660	2900	2460
Unisex-ness	20	2140	2660	2760	2100
Minimalistic	20	2080	2660	2820	2680
Dynamic	15	1980	1530	1665	1490
Vibrant	15	2160	1995	1755	2415
Fresh	10	1340	1050	1090	1650
Campus-ness	5	565	650	630	625
Cumulative		12385	13205	13620	13420

The concept 3 with 13620 points is selected as the final concept, and is further developed in to the final design and taken for the modelling. The user evaluation reveals that the concept 3 is more closer to the design brief. According to the users this concept is more lighter, minimalistic and unisex in design.

14. Final concept

Features

- Sleek design.
- Unisex frame
- Minimalistic
- Dynamic
- Vibrant colour scheme
- UV coated PP mudguard
- Forward and backward adjustable seat.
- 6 speed derailleur gear

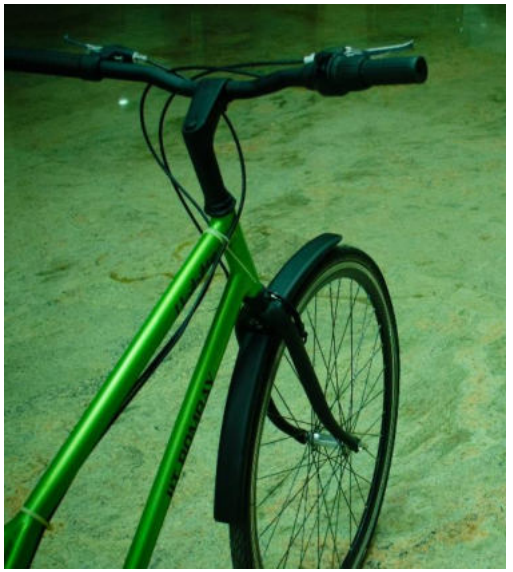
15. Model making

Continued...

Continued...

16. Finished model

Continued...



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17. References

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